IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:
Baldwin :Art Unit: 3661
Serial No. 09/133,741 :Examiner: Thu Nguyen
Filed: 08/13/1998 :Atty's Docket: TD-143
For: Improved Triangle Clipping for 3D Graphics (confirmation no. 6925)

APPEAL BRIEF

Honorable Commissioner of Patents and Trademarks
Alexandria, VA 22313

Sir:

Applicants herewith respectfully submit that the Examiner's decision of 06/04/2002, finally rejecting Claims 1-3, 7-18, 20-27, and 47-52 in the present application, should be reversed, in view of the following arguments and authorities.

TABLE OF CONTENTS

Real Party in Interest

The real party in interest, and assignee of this case, is 3DLabs Inc., Ltd., which is now a subsidiary of Creative Technologies, of Singapore.

Related Appeals or Interferences

To the best knowledge and belief of the undersigned attorney, there are none. However, please note that 09/280,250 is another case of common assignee which is currently on appeal, and which involves the same general field of technology.

Status of Claims

Claims 1-3, 7-27, and 47-52 are pending, and are each under final rejection. Claim 19 is hereby canceled and removed from consideration. Claims 4-6 and 28-46 have been canceled by previous amendments. Claims 1-3, 7-18, 20-27, and 47-52 are now the subject of this appeal. No other claims are pending.

Status of Amendments after Final

Two proposed amendments were submitted concurrently with the original Appeal Brief, for the Examiner's consideration as a way to remove issues from this appeal, and/or for the Board's consideration as a possible Board Recommendation under Rule 196. However, the Examiner has refused to submit the proposed amendments for the Board's consideration. Therefore, there have been no amendments after final.

SUMMARY OF INVENTION

The following summary refers to disclosed embodiments and their advantages, but does not delimit any of the claimed inventions.

In General

Unlike traditional clipping methods which store the input and output clipped polygons in two separate buffers which are ping-ponged between, the disclosed improved clipping method uses circular buffering. A circular buffer is advantageous in an iterative clipping algorithm because the entries are processed sequentially and once an entry has been processed it is not needed again.

Another advantage is that the use of circular buffering eliminates the ping-pong effect of accessing two separate buffers for polygon clipping.

Detailed Structure

Figure 8 depicts a block diagram of a circular buffer for storing input and output clipped polygons. This clipping circular buffer is 16 entries deep, one entry per vertex. Each entry is 109 bits wide, holding: a barycentric coordinate consisting of three floating point values, a twelve bit outcode, and an edge flag indicating if the barycentric point is on the edge of a particular plane. Pointers OutVertex and InVertex are used to mark the head and tail of the circular buffer, respectively.

Hardware Context

A functional block diagram of the preferred system is shown in **Figure 1**. This figure shows the core of the GAMMA architecture. The GAMMA architecture is based on a message passing paradigm. In this system all the processing units are connected in a long pipeline with communication with the adjacent units being accomplished through message passing. Between each unit there is a small amount of buffering, the size being specific to the local communications requirements and speed of the two units.

The message rate is variable and depends on the rendering mode. The messages do not propagate through the system at a fixed rate typical of a more traditional pipeline system. If the receiving unit cannot accept a message because its input buffer is full, the sending unit stalls until space is available.

The message structure is fundamental to the whole system as the messages are used to control, synchronize and inform each unit about the processing it is to undertake. Each message has two fields - a data field and a tag (command) field. The data field will hold color information, coordinate information, local state information, etc. The tag field is used by each block to identify the message type so it knows how to act on it. The GAMMA architecture has a message bus with an 11 bit tag width and a 128 bit data width. The large data width allows a 4 component coordinate or color to be transferred between units in a single cycle.

The GAMMA architecture employs lazy evaluation. That is, effort is only spent calculating a parameter that is actually needed. This is especially true with lighting calculations. Lighting calculations require multiple vertices in order to determine backface orientation. Therefore, lighting is deferred until after primitives which will not be displayed are clipped out. In the same manner,

texture, fog, and other parameter calculations that are necessary only for display purposes are deferred until after clipping has been performed.

The Command Unit **102** performs direct memory access (DMA) functions required by the GAMMA accelerator. In addition to DMA functions, the Command Unit 102 implements circular buffering. Circular buffering allows the DMA controller to treat a region of memory as a first in first out (FIFO) structure.

The Vertex Machinery Unit **104** expands Open GL commands and their subsequent vertices in order that the rest of the units in the pipeline can operate within the message paradigm.

The function of the Transformation Unit **106** is to transform the coordinates of vertices, normals, or texture coordinates for use by the successive units. Transformation of the coordinates can include translation, rotation, and modification of coordinate space (eye space, normalized device coordinates, etc.). The Transformation Unit 106 contains space for both 3D and 2D coordinate transformations. In the presently preferred embodiment, the Transformation Unit 106 transforms incoming coordinates into a special clipping space. This clipping space is defined by a viewing frustrum with sides at 45 degrees, as depicted in Figure 3. The angle of the sides of the viewing frustrum enables easier calculation of primitive intersections. Once the coordinates have been transformed to the special clipping space, each vertex in the triangle primitive is assigned a fixed barycentric coordinate: (1,0,0), (0,1,0), (0,0,1).

The Geometry Unit **108** takes incoming vertices and calculates outcodes (for clipping) and projected window coordinates. Clipping of most primitives is performed here. Calculations such as lighting, fog, and texture are deferred until after the Geometry Unit 108 in

order to allow the clip test to take place, saving processing time further down the pipeline.

The Normalization Unit **110** transforms and normalizes normals once the clip test and backface culling have demonstrated they are definitely needed for the lighting calculations.

The Lighting Unit **112**, under the direction of the Geometry Unit 108, evaluates the lighting equations for a vertex and sends the ambient, diffuse, and specular light values to the Material Unit **114**. Although only one Lighting Unit 112 is shown, several such units can be cascaded together to improve performance for multiple lighting graphics.

The Material Unit 114, also under the direction of the Geometry Unit 108, combines calculated light values with material properties, such as diffuse reflectance coefficient, to determine the color of a vertex.

The Delta Unit **116** calculates triangle and line set up parameters when the rasterizer chip is incapable of such calculations.

ISSUES

1. **Are Claims 1-2, 7-11, 14-15, 48, and 50-51 obvious over Rossin et al. in view of Sutherland?**
2. **Are Claims 16-17, 20-24, 27, and 47 obvious over Rossin et al. in view of Sutherland and Watkins et al.?**
3. **Are Claims 3, 12-13, 49, and 52 obvious over Rossin et al. in view of Sutherland and Narayanaswami?**
4. **Are Claims 18 and 25 obvious over Rossin et al. in view of Sutherland, Watkins et al., and Narayanaswami?**

Grouping of Claims

The claims on appeal do not stand or fall together, as may be seen from the arguments set forth below. Each claim should be considered separately.

ARGUMENT

Stated Grounds of Rejection

The rejections outstanding against the Claims are as follows:[1]

1. Claims 1-2, 7-11, 14-15, 48, and 50-51 have been rejected as obvious over Rossin et al. in view of Sutherland. See item 4 in the 06/04/2002 Office Action.
2. Claims 16-17, 20-24, 26-27, and 47 have been rejected as obvious over Rossin et al. in view of Sutherland and further in view of Watkins et al. See item 5 in the 06/04/2002 Office Action.
3. Claims 3, 12-13, 49, and 52 have been rejected as obvious over Rossin et al. in view of Sutherland and further in view of Narayanaswami. See item 6 in the 06/04/2002 Office Action.
4. Claims 18 and 25 have been rejected under § 103, as obvious over Rossin et al. in view of Sutherland and further in view of Watkins et al. and Narayanaswami. See item 7 in the 06/04/2002 Office Action.

[1] A §112(2) objection was also stated against Claims 29-35, but has been mooted by the cancellation of those claims.

Rejections under §103

Legal Standards

Any obviousness rejection requires some showing of motivation to modify or combine the reference(s) applied, in a way which meets the claimed invention. In the long line of case law stemming from *Graham v. John Deere,*[2] many Federal Circuit opinions have summarized this legal requirement; one frequently-cited recent case is *In re* Rouffet.[3] This opinion states very emphatically (with many citations):[4]

> [T]he examiner must show reasons that the skilled artisan, confronted with the same problems as the inventor and with no knowledge of the claimed invention, would select the elements from the cited prior art references for combination **in the manner claimed**.[5]

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[2] *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966).

[3] 149 F.3d 1350, 47 USPQ2d 1453 (Fed.Cir. 1998).

[4] Cases cited to support the Court's emphasis on motivation include: *In re Geiger*, 815 F.2d 686, 2 USPQ2d 1276 (Fed.Cir. 1987); *Pro-Mold & Tool Co. v. Great Lakes Plastics, Inc.*, 75 F.3d 1568, 37 USPQ2d 1626 (Fed.Cir. 1996); *In re Sernaker*, 702 F.2d 989, 217 USPQ 1 (Fed.Cir. 1983); *Ashland Oil, Inc. v. Delta Resins & Refractories, Inc.*, 776 F.2d 281, 227 USPQ 657 (Fed.Cir. 1985); *In re Beattie*, 974 F.2d 1309, 24 USPQ2d 1040 (Fed.Cir. 1992); *Lindemann Maschinenfabrik GmbH v. American Hoist & Derrick Co.*, 730 F.2d 1452, 221 USPQ 481 (Fed.Cir. 1984); *Environmental Designs, Ltd. v. Union Oil Co.*, 713 F.2d 693, 218 USPQ 865 (Fed.Cir. 1983); *Richdel, Inc. v. Sunspool Corp.*, 714 F.2d 1573, 219 USPQ 8 (Fed.Cir. 1983); and *Sensonics, Inc. v. Aerosonic Corp.*, 81 F.3d 1566, 38 USPQ2d 1551 (Fed.Cir. 1996).

[5] In re Rouffet, 149 F.3d at 1357 (emphasis added).

Even more recently *In re Lee*[6] emphasized (with many citations[7]) that: "The need for specificity pervades this authority."

A similarly emphatic discussion is found in *Ruiz v. A.B. Chance Co.*, where the Court, after a long review of the case law, concludes that the showing of combinability must be "**clear and particular.**"[8]

In *Thrift*[9] a rejection which "does not discuss the unique limitations" of the claims was held to be "simply inadequate on its face." In this case a rejection was held "not supported by substantial evidence because **the cited references do not support each limitation** of claim 11. See *In re Vaeck*, 947 F.2d 488, 493, 20 USPQ2d 1438, 1443 (Fed.Cir. 1991)."[10]

The Board too has held to this standard; see e.g. *Ex parte Levengood*, 28 USPQ2d 1300, 1304-05 (B.P.A.I. 1993), *Ex parte Obukowicz*, 27 USPQ2d 1063, 1065 (B.P.A.I. 1992), and *Ex parte Clapp*, 227 USPQ 972, 973 (B.P.A.I. 1985).

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[6] 277 F.3d 1338, 61 USPQ2d 1430 (Fed.Cir. 2002), cited and applied, e.g., by *In re Huston*, 308 F.3d 1267, 64 USPQ2d 1801 (Fed.Cir. 2002). Note that Huston upheld a rejection, but explicitly applied *Lee*'s standard.

[7] The Court's opinion cites *In re Dance* 160 F.3d 1339, 48 USPQ2d 1635 (Fed.Cir. 1998), *Rouffet*, and many other cases in the same vein, including *In re Grasselli*, 713 F.2d 731, 218 USPQ 769 (Fed.Cir. 1983); *McGinley v. Franklin Sports, Inc.*, 262 F.3d 1339, 60 USPQ2d 1001 (Fed.Cir. 2001); *Brown & Williamson Tobacco Corp. v. Philip Morris, Inc.*, 229 F.3d 1120, 56 USPQ2d 1456 (Fed.Cir. 2000); *C.R. Bard, Inc., v. M3 Systems, Inc.*, 157 F.3d 1340, 48 USPQ2d 1225 (Fed.Cir. 1998); *In re Dembiczak*, 175 F.3d 994, 50 USPQ2d 1614 (Fed.Cir. 1999); *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed.Cir. 1988); *ACS Hosp. Sys., Inc. v. Montefiore Hosp.*, 732 F.2d 1572, 221 USPQ 929 (Fed.Cir. 1984); and *In re Fritch*, 972 F.2d 1260, 23 USPQ2d 1780 (Fed.Cir. 1992).

[8] 234 F.3d 654, 57 USPQ2d 1161 (Fed.Cir. 2000), citing *In re Dembiczak*, 175 F.3d at 999 (emphasis added here by Applicant).

[9] *In re Thrift*, 298 F.3d 1357 (Fed.Cir. 2002).

[10] *In re Thrift*, 298 F.3d at 1366 (emphasis added).

Even the Manual of Patent Examining Procedure, citing many of these cases, uses an entire subsection (MPEP §§2143.03) to emphasize that an alleged motivation must meet ALL LIMITATIONS of the claimed invention.[11]

Review of the References

Some of the major technical differences between the references applied and the disclosure of the present application will now be reviewed. Of course, these points in the specification do not define the scope or interpretation of any of the claims; they are listed merely to help appreciate the importance of the claim distinctions which will be reviewed thereafter.

Rossin et al. 5,877,773

Rossin et al., as Examiner Nguyen has correctly noted, does not teach "using only one circular buffer for storing input and output vertices...."

Sutherland "Micropipelines"

This prizewinning paper provides very general teachings regarding the use of circular buffers. The key passage in Sutherland appears to be at the top left of page 735, near the end of the article:

> Perhaps the most important application of micropipelines will involve operations in which the vector length changes. One such example is the clipping operation widely used in computer graphics. The clipping operation removes the parts of a set of objects that lie outside a reference window.

[11] Of course the MPEP is not authority which binds the Board, but is noted merely as a convenient and well-written summary of relevant points of case law.

> Clipping may result in an increase or decrease in the number of objects in the set. ...

This passage certainly does suggest the use of circular buffers in connection with clipping operations, but does not suggest COMBINING two conventional circular buffers into one.

Applicant is not claiming to have invented circular buffers as such; the claims in the present application present a specific use of circular buffers, which goes beyond the teaching of the "Micropipelines" article. For example, consider the application of Sutherland's teaching to the example given on pages 10 and 11 of the present application as filed:

> The Sutherland and Hodgman clipping technique is an iterative process which clips by comparing each polygon (primitive) to a particular clipping plane of the frustrum (near, far, left, right, top, and bottom). The result is a new output polygon, a set of vertices which defines the clipped area that is in the interior of the frustrum with respect to the particular clipping plane. ...
>
> The clipping algorithm for a polygon against a single clipping plane considers the input vertices P_1, P_2, . . . P_n one at a time. For each such input vertex zero, one or two of the output vertices Q_1, Q_2, ... Q_m will be generated, depending on the input with respect to the clipping plane. ...
>
> The usual implementation of the Sutherland and Hodgman algorithm requires the use of two separate buffers for holding the vertices of the input and output polygons. ... [E]ach buffer must be large enough to hold the maximum number of vertices that can be produced. Each clip plane

can add at most one extra vertex so with 12 clip planes and 4 vertices enough storage for a maximum of 16 vertices is required in each of the two buffers.

Sutherland does not go beyond this conventional approach, but merely provides the foundation for it: each of the two conventional buffers (for the two polygons being handled) carries a variable-length vector of vertices (between 4 and 16 inclusive, in this example), and can be implemented in accordance with the Sutherland article. However, this does not suggest combining two circular buffers into one.

Thus Examiner Nguyen is correct that Sutherland suggests using a circular buffer in connection with clipping. However, that is not the point: the question is whether Sutherland suggests combining two Sutherland-type circular buffers to make one Sutherland-type circular buffer. Sutherland does not appear to suggest this.

Watkins et al. 5,361,386

Watkins et al. does indeed teach use of barycentric coordinates in computer graphics calculations, although not in connection with clipping.

Narayanaswami 5,613,052

Narayanaswami does indeed teach performing at least some coloring operations only on pixels which have passed a clipping test.

Combination Does Not Meet the Claims

The outstanding rejections do not meet the limitations in the independent claims, e.g.:

Claim 1: "performing a clipping algorithm which uses only a single circular buffer to store input and output vertices of a primitive;"

Claim 16: "circuitry to implement a clipping algorithm which uses only a single circular buffer to store input and output vertices of a primitive;"

Claim 48: "wherein said geometry unit uses only a single circular buffer to store input and output vertices of said primitive."[12]

The Examiner has suggested reasons for modifying the primary references to use a circular buffer. However, it is respectfully submitted that the Examiner has not shown any motivation for using ONLY A SINGLE circular buffer in the context of these claims.

[12] Typographical emphasis here is used to indicate limitations which have not been met, and does not imply that other limitations are not also important, nor that these limitations are not entitled to a full scope of interpretations and equivalents.

No Motivation to Combine or Modify

The Examiner has not shown any reason why one of ordinary skill would modify the conventional ping-pong clipping architecture of two circular buffers to achieve one circular buffer. The fact that Sutherland's architecture can be used to implement each of the two conventional circular buffers, OR to implement the single circular buffer provided by the present application, is simply irrelevant to whether the two should be combined.

Particular Nonobvious Limitations

In addition to the various limitations of the various independent claims, as noted above, none of the references, singly or in combination, are seen to teach or suggest the claimed features of: "said circular buffer has a maximum storage of sixteen vertices" as recited, with other limitations, in the context of Claim 15. This is particularly important in relation to embodiments where 12 clipping planes are permitted, since this claim's limitation restricts the single buffer's size to half that which would have been used for the two conventional buffers (in the prior art example of page 11 line 7).

Grouping of Claims

The claims on appeal do not stand or fall together, since they contain distinct recitations which are relevant to patentability and to the specific rejections stated. For example, in addition to the claim extracts quoted above from Claims 1, 16, and 48:

Claims 11 and 24 separately recite, among other differing limitations, that "said clipping algorithm is the Sutherland and Hodgman polygon clipping algorithm."

Claim 15 recites, among other limitations, that "said circular buffer has a maximum storage of sixteen vertices."

Claim 16 recites, among other limitations, "circuitry to set an outcode value for each of said vertices indicating whether it is visible with respect to individual planes of said view volume."

Claim 16 also recites, among other limitations, "circuitry to define all vertices of a primitive using relational coordinates...."

Claim 21 also recites, among other limitations, barycentric coordinates.

Claim 48 is very different from the other independent claims. For example, Claim 48 recites, among other limitations, both a transformation unit and also a geometry unit.

Claim 48 also recites, among other limitations, video rendering hardware.

Claim 48 also recites, among other limitations, display hardware.

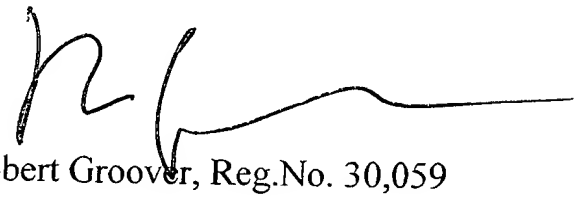
Claim 48 also recites, among other limitations, a processor connected to provide graphics data.

Each claim should be considered separately; or at the very least each claim which is argued separately in the preceding sections of this brief should be considered separately. Argument: The fact that the claims use different formulations (as detailed above) and/or have been argued separately, shows that, if their patentability is not considered separately, any adverse decision would show that the limitations of some claims had been unfairly ignored.

REQUESTED RELIEF

The Board is respectfully requested to reverse the outstanding rejections.

Respectfully submitted,



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Serial No. 09/133,741 :Examiner: Thu Nguyen
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For: Improved Triangle Clipping for 3D Graphics

APPENDIX A - Text of Claims on Appeal

1. A method for clipping graphics primitives for display, comprising the steps of:

performing a clipping algorithm which uses only a single circular buffer to store input and output vertices of a primitive; and

for each one of said vertices, indicating whether said one of said vertices is visible with respect to each plane of a view volume.

2. The method of Claim 1, wherein only vertices which are visible in all said planes are rasterized.

3. The method of Claim 1, wherein said performing step is executed prior to any lighting, fog, or texture calculations.

7. The method of Claim 1, wherein said view volume is a frustrum.

8. The method of Claim 1, wherein there are six or more planes in said view volume.

9. The method of Claim 1, wherein there are six planes in said view volume.

10. The method of Claim 1, wherein there are twelve planes in said view volume.

11. The method of Claim 1, wherein said clipping algorithm is the Sutherland and Hodgman polygon clipping algorithm.

12. The method of Claim 1, wherein vertex visibility in each of said planes is indicated by a bit flag.

13. The method of Claim 1, wherein vertex visibility is indicated by twelve bit code.

14. The method of Claim 1, wherein two circular buffers are used to store said input and output polygons.

15. The method of Claim 1, wherein said circular buffer has a maximum storage of sixteen vertices.

16. A geometry unit, comprising:

circuitry to define all vertices of a primitive using relational coordinates;

circuitry to implement a clipping algorithm which uses only a single circular buffer to store input and output vertices of a primitive; and

circuitry to set an outcode value for each of said vertices indicating whether it is visible with respect to individual planes of said view volume.

17. The geometry unit of Claim 16, wherein only vertices which are visible in all said planes are rasterized.

18. The geometry unit of Claim 16, wherein said clipping algorithm is implemented prior to any lighting, fog, or texture calculations.

20. The geometry unit of Claim 16, wherein said primitive is a triangle.

21. The geometry unit of Claim 16, wherein said relational coordinates are barycentric.

22. The geometry unit of Claim 16, wherein said view volume is a frustrum.

23. The geometry unit of Claim 16, wherein there are six or more planes in said view volume.

24. The geometry unit of Claim 16, wherein said clipping algorithm is the Sutherland and Hodgman polygon clipping algorithm.

25. The geometry unit of Claim 16, wherein vertex visibility in each of said planes is indicated by a bit flag.

26. The geometry unit of claim 16, wherein two circular buffers are used to store said input and output polygons.

27. The geometry unit of Claim 16, wherein said circular buffer has a maximum storage of sixteen vertices.

47. The method of Claim 1, further comprising defining all said vertices of said primitive using relational coordinates.

48. A computer system comprising:

display hardware;

a processor connected to provide graphics data;

a geometry and lighting accelerator connected to receive said graphics data, said geometry and lighting accelerator comprising:

a transformation unit connected to transform a primitive into a clipping space, and

a geometry unit connected to

perform clip testing on said primitives,

clip said primitives, if necessary,

set an outcode value for each said vertex indicating whether it is visible with respect to each plane of a view volume, and

output clipped graphics data to be rendered; and

video rendering hardware connected to receive said clipped graphics data and to generate graphics, and connected to display said graphics on said display hardware;

wherein saidgeometry unit uses only a single circular buffer to store input and output vertices of said primitive.

49. The computer system of Claim 48, wherein said clipping is implemented prior to any lighting, fog, or texture calculations.

50. The computer system of Claim 48, wherein said primitive is a triangle.

51. The computer system of Claim 48, wherein said clipping uses the Sutherland and Hodgman polygon clipping algorithm.

52. The computer system of Claim 48, wherein vertex visibility in each of said planes is indicated by a bit flag.

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For: Improved Triangle Clipping for 3D Graphics

NOTICE OF APPEAL

Honorable Commissioner of Patents and Trademarks
Washington, DC 20231

Sir:

Appeal is hereby lodged from the Examiner's final rejection of 6/4/2002 against Claims 1-3, 7-27, 29-35 and 47-52. (The accompanying cover sheet contains a fee authorization and a request for any necessary extension of time.)

Respectfully submitted,

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November 4, 2002

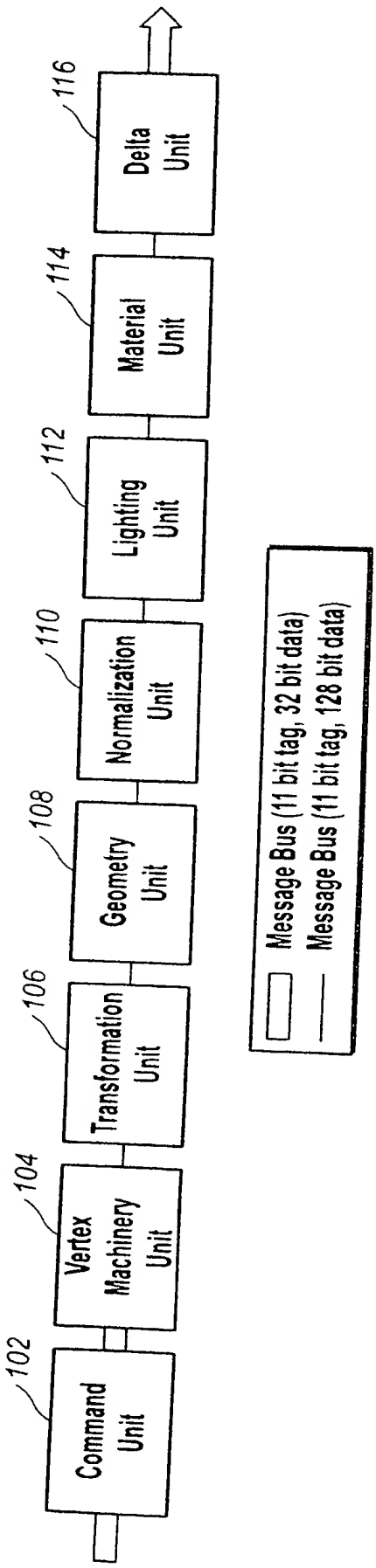

FIG. 1

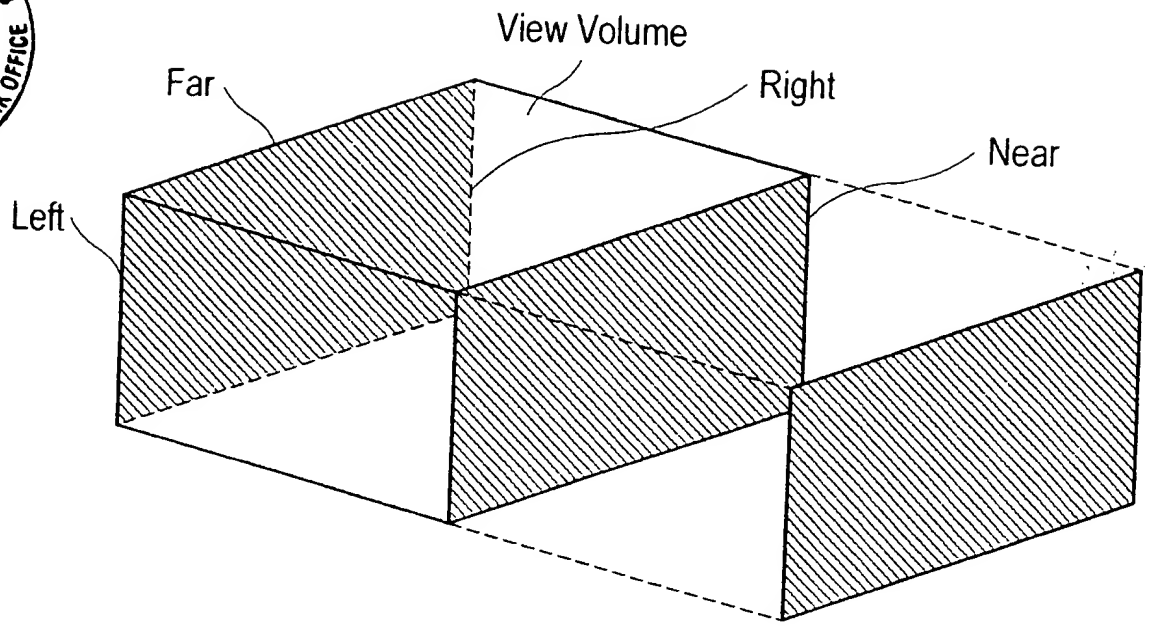

FIG. 2

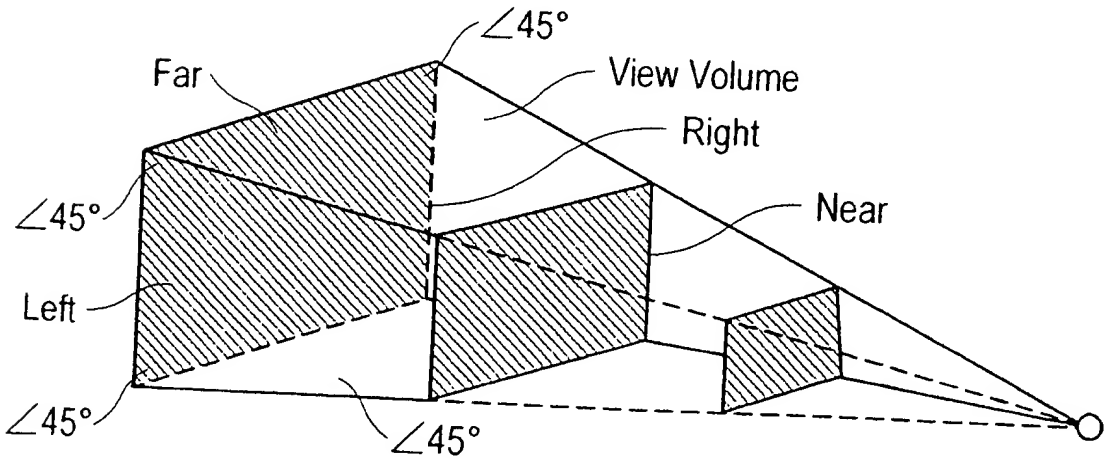

FIG. 3

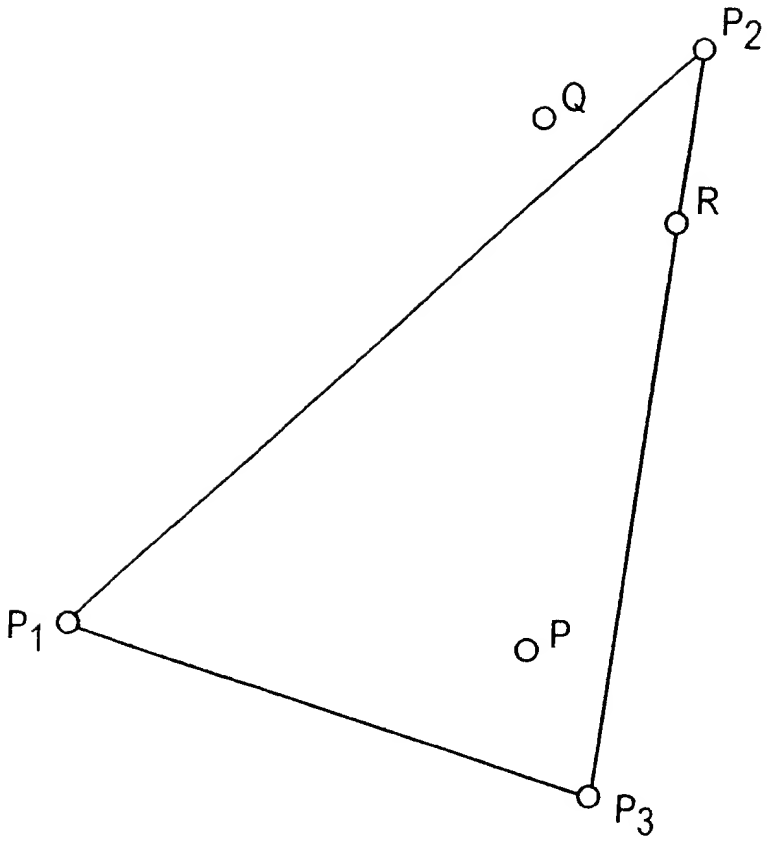

FIG. 4

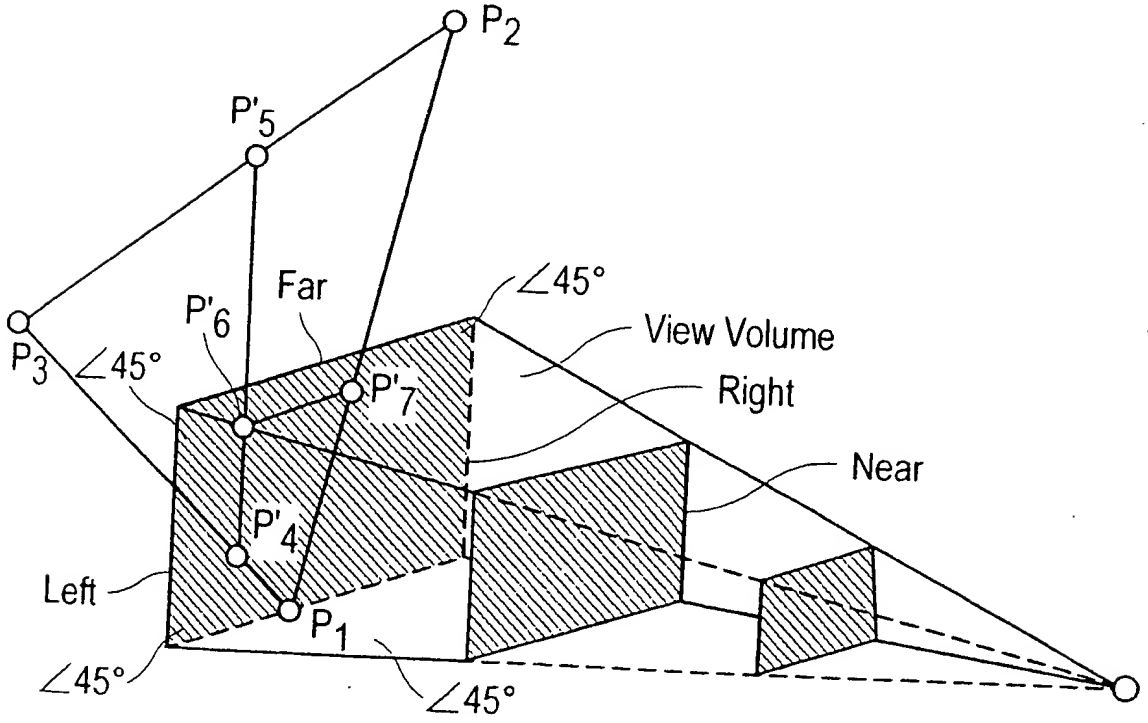

FIG. 5

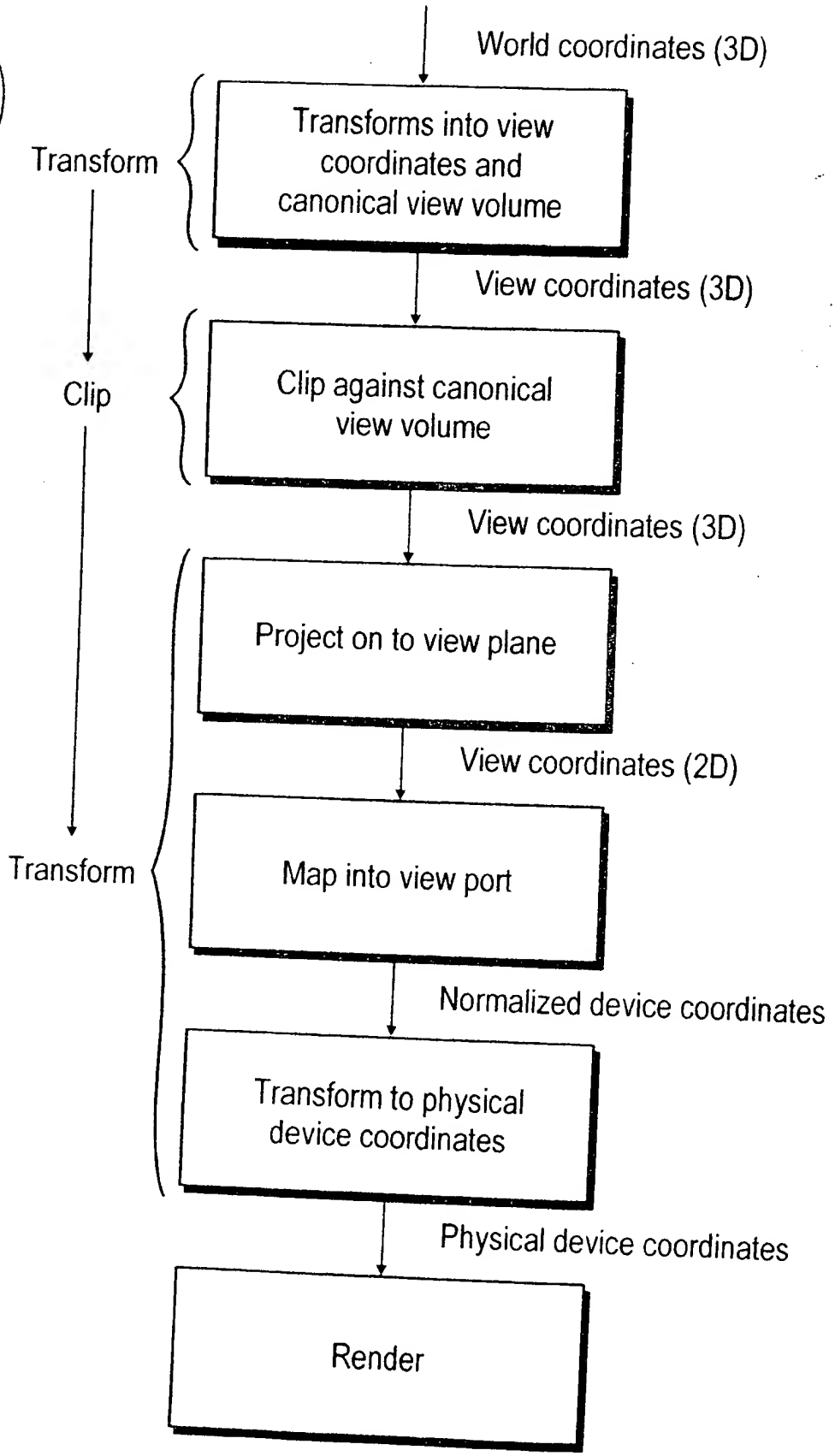

FIG. 6

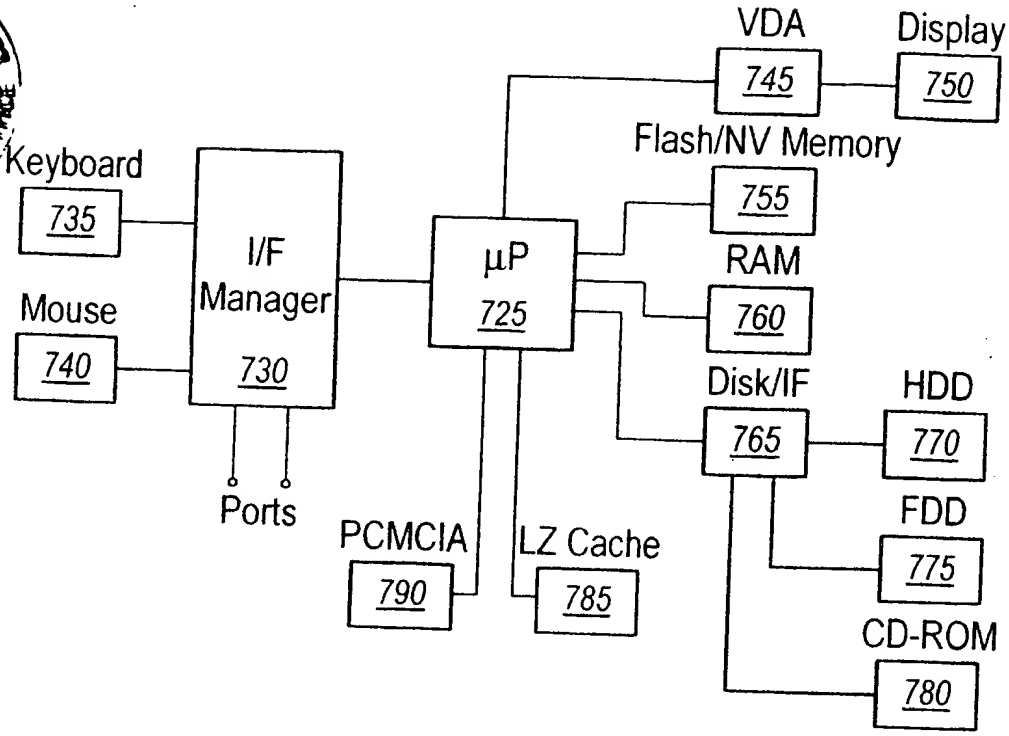

FIG. 7

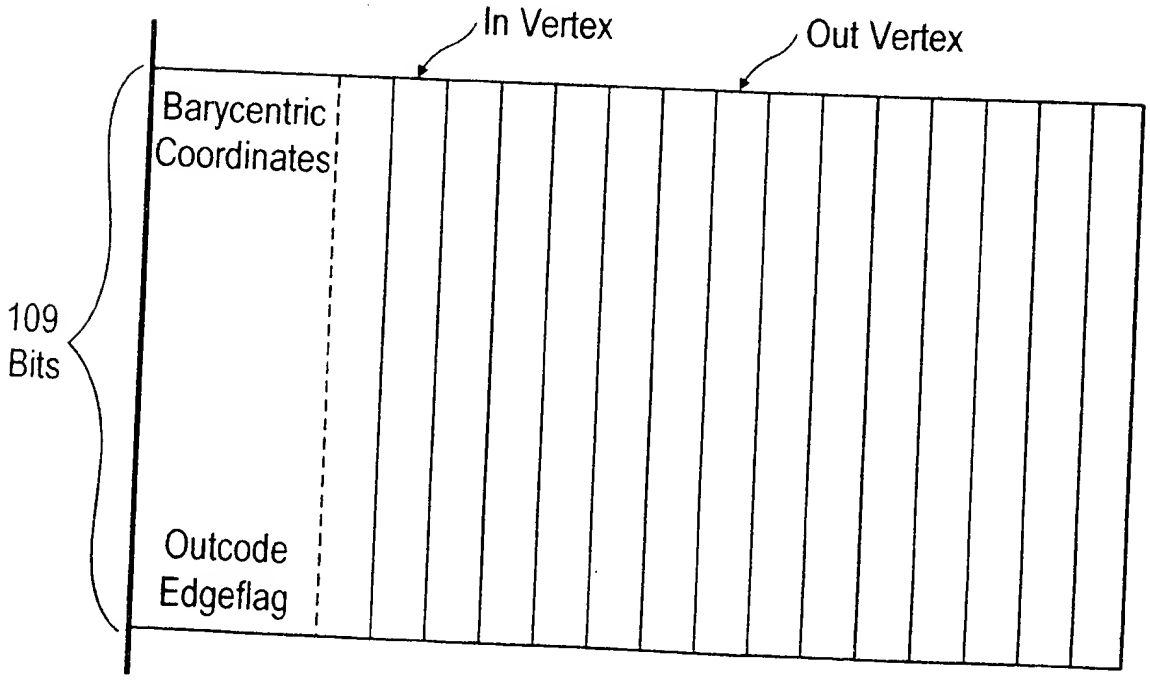

FIG. 8

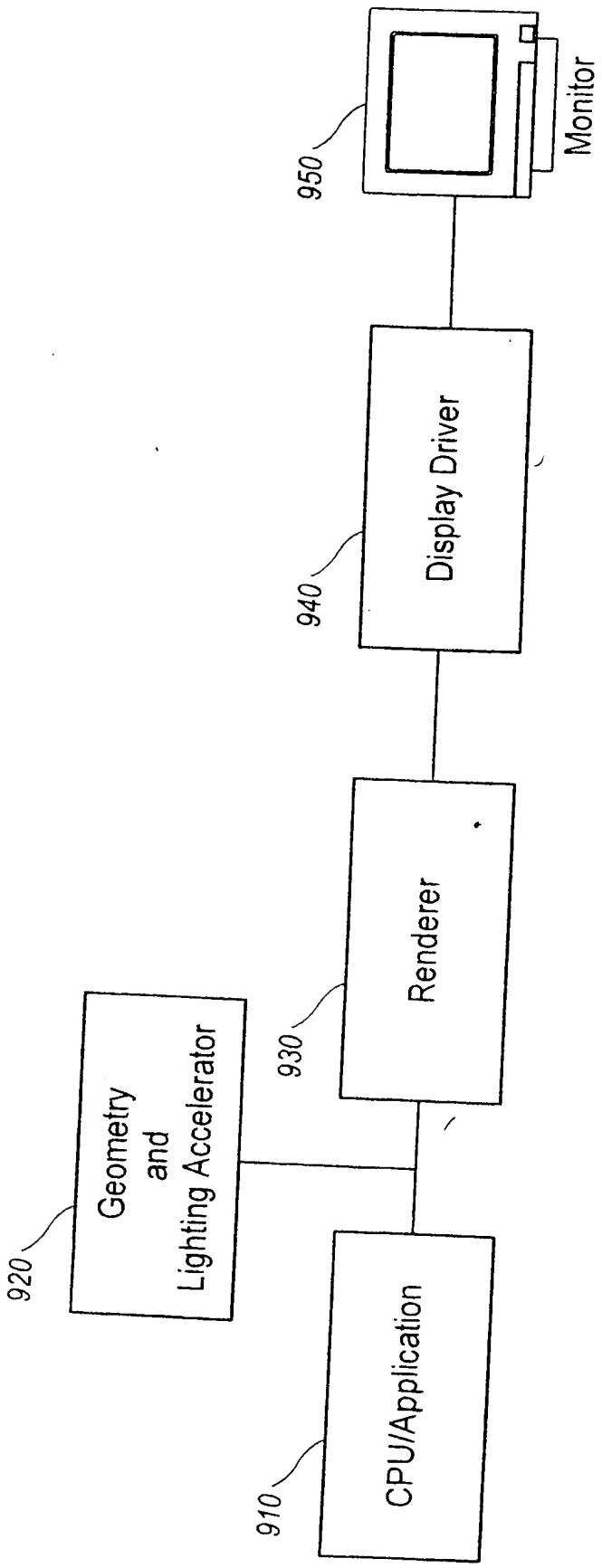

FIG. 9